In re: Kwang-hee Lee et al. Serial No.: 10/801,208

Filed: March 16, 2004

Page 2

## In the claims:

The claims have not been amended. The following Claim Listing is provided for the Examiner's convenience.

1. (Cancelled)

2. (Previously Presented) A method of fabricating a capacitor, the method comprising:

forming a lower electrode on a substrate;

forming a dielectric layer on the lower electrode; and

forming an upper electrode on the dielectric layer to provide a capacitor that comprises the lower electrode, the dielectric layer and the upper electrode;

wherein forming the lower electrode on the substrate comprises at least forming a ruthenium seed layer using atomic layer deposition on the substrate and forming a main ruthenium layer on the ruthenium seed layer using chemical vapor deposition.

- 3. (Original) The method of Claim 2, further comprising forming a storage node contact plug on the semiconductor substrate and a storage node that is electrically connected to the storage node contact plug to provide a semiconductor memory device, wherein the ruthenium seed layer is formed on the storage node contact plug.
- 4. (Previously Presented) A method of fabricating an electrode for a microelectronic device, the method comprising:

forming a ruthenium seed layer using atomic layer deposition on a semiconductor substrate;

forming a main ruthenium layer on the ruthenium seed layer; and patterning the main ruthenium layer and the ruthenium seed layer to form the electrode;

wherein forming the ruthenium seed layer using atomic layer deposition comprises at least one cycle of:

In re: Kwang-hee Lee et al.

Serial No.: 10/801,208 Filed: March 16, 2004

Page 3

injecting a ruthenium source into a chamber containing the semiconductor substrate; then

injecting an oxygen-containing gas into the chamber containing the semiconductor substrate; and then

injecting hydrogen-containing gas into the chamber containing the semiconductor substrate, wherein the hydrogen-containing gas comprises molecular hydrogen (H<sub>2</sub>) and/or ammonia (NH<sub>3</sub>).

- 5. (Previously Presented) The method of Claim 4, further comprising purging the chamber following the injection of the ruthenium source, the injection of the oxygen-containing gas, and the injection of the hydrogen-containing gas.
- 6. (Previously Presented) The method of Claim 4, wherein the oxygen-containing gas comprises an O<sub>2</sub> gas, an O<sub>3</sub> gas, and/or an H<sub>2</sub>O gas.
- 7. (Previously Presented) The method of Claim 4, wherein at least one of the oxygen-containing gas or the hydrogen-containing gas is supplied in a plasma phase.
- 8. (Previously Presented) The method of Claim 4, wherein injecting the ruthenium source, injecting the oxygen-containing gas, and injecting the hydrogen-containing gas into the chamber is performed at least twice until the ruthenium seed layer is grown to a desired thickness.
- 9. (Previously Presented) The method of Claim 3, wherein the ruthenium seed layer is formed to a thickness of about 5 Å to 50 Å and wherein the main ruthenium layer is formed to a thickness of 50 Å to 300 Å.
- 10. (Previously Presented) The method of Claim 9, wherein the forming of the main ruthenium layer comprises supplying oxygen at a flow rate of about 1 sccm to 50 sccm and supplying a ruthenium source at a flow rate of about 0.1 ccm to 2 ccm under a pressure of about 0.4 Torr to 0.6 Torr.

In re: Kwang-hee Lee et al. Serial No.: 10/801,208

Filed: March 16, 2004

Page 4

11. (Original) The method of Claim 2, wherein the dielectric layer comprises a tantalum oxide layer.

12. (Previously Presented) A method of fabricating an electrode for a microelectronic device, the method comprising:

forming a ruthenium seed layer using atomic layer deposition on a semiconductor substrate;

forming a main ruthenium layer on the ruthenium seed layer;

forming a dielectric layer on the main ruthenium layer; and

forming an upper electrode on the dielectric layer to provide a capacitor;

wherein the main ruthenium layer is formed using chemical vapor deposition;

wherein the forming of the upper electrode comprises:

forming a second ruthenium seed layer using atomic layer deposition on the dielectric layer; and

forming a second main ruthenium layer on the second ruthenium seed layer.

- 13. (Cancelled)
- 14. (Previously Presented) The method of Claim 4, wherein the ruthenium seed layer has an oxygen concentration of less than 5%.
  - 15-33. (Cancelled)
- 34. (Previously Presented) The method of Claim 8, wherein the hydrogen-containing gas is injected into the chamber after the oxygen-containing gas is injected into the chamber but before the ruthenium source is again injected into the chamber.
- 35. (Previously Presented) A method of fabricating an electrode for a microelectronic device, the method comprising:

forming a storage node contact plug on a semiconductor substrate;

forming a ruthenium seed layer using atomic layer deposition on the storage node

In re: Kwang-hee Lee et al. Serial No.: 10/801,208

Filed: March 16, 2004

Page 5

contact plug by injecting a ruthenium source into a chamber containing the semiconductor substrate, and then injecting a first oxygen-containing gas into the chamber containing the semiconductor substrate, and then injecting a second hydrogen-containing gas that is different than the first oxygen-containing gas into the chamber containing the semiconductor substrate; and then

forming a main ruthenium layer on the ruthenium seed layer;

patterning the main ruthenium layer and the ruthenium seed layer to form the electrode;

forming a dielectric layer on the electrode; and forming an upper electrode on the dielectric layer to provide a capacitor.

- 36. (Previously Presented) The method of Claim 35, further comprising purging the chamber following the injection of the ruthenium source, the injection of the first oxygen-containing gas, and the injection of the second hydrogen-containing gas.
- 37. (Previously Presented) The method of Claim 36 wherein the first oxygen-containing gas comprises an O<sub>2</sub> gas, an O<sub>3</sub> gas, and/or an H<sub>2</sub>O gas and the second hydrogen-containing gas comprises an H<sub>2</sub> gas and/or an NH<sub>3</sub> gas.
- 38. (Previously Presented) The method of Claim 37, wherein at least one of the oxygen-containing gas or the hydrogen-containing gas is supplied in a plasma phase.
- 39. (Previously Presented) The method of Claim 38, wherein the main ruthenium layer is formed using chemical vapor deposition.
- 40. (Previously Presented) The method of Claim 39, wherein injecting the ruthenium source, injecting the first oxygen-containing gas, and injecting the second hydrogen-containing gas into the chamber is performed at least twice until the ruthenium seed layer is grown to a desired thickness.
  - 41. (Previously Presented) The method of Claim 40, wherein the ruthenium seed

In re: Kwang-hee Lee et al. Serial No.: 10/801,208 Filed: March 16, 2004

Page 6

layer has an oxygen concentration of less than 5%.

- 42. (Previously Presented) The method of Claim 41, wherein the ruthenium seed layer is formed to a thickness of about 5 Å to 50 Å and wherein the main ruthenium layer is formed to a thickness of 50 Å to 300 Å.
- 43. (Previously Presented) The method of Claim 42, wherein the forming of the main ruthenium layer comprises supplying oxygen at a flow rate of about 1 sccm to 50 sccm and supplying a ruthenium source at a flow rate of about 0.1 ccm to 2 ccm under a pressure of about 0.4 Torr to 0.6 Torr.
- 44. (Previously Presented) The method of Claim 43, wherein the dielectric layer comprises a tantalum oxide layer.
- 45. (Previously Presented) The method of Claim 44, wherein the forming of the upper electrode comprises:

forming a second ruthenium seed layer using atomic layer deposition on the dielectric layer; and

forming a second main ruthenium layer on the second ruthenium seed layer.

- 46. (Cancelled)
- 47. (Previously Presented) The method of Claim 35, wherein the second hydrogencontaining gas does not include oxygen.